



The Sensor Web Enablement Framework

(Status and Plans for Sensor Web Technology at OGC)

Open GIS Consortium, Inc.

OGC Interoperability Program

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Briefing Topics

- About OGC
- Sensor Web Enablement (SWE) Overview
- SWE Architecture Concepts
- SWE Applications
 - Relevance to “Intelligent Jobsite”
- SWE Development Plans

Open GIS Consortium.... Nine Years in the Making

- Not-for-profit, international consortium whose 250+ industry, government, and university members work to make geographic information an integral part of information systems of all kinds
 - Operates a *Specification Development Program* similar to other Industry consortia (W3C, OMG, etc.).
 - Operates an *Outreach Program* to facilitate the adoption of OGC technology and to identify new requirements for interoperability.
 - Operates an *Interoperability Program* (IP), an innovative, partnership-driven, hands-on collaborative engineering and testing program designed to deliver proven specifications into the Specification Development Program.

OGC Vision

A world in which everyone benefits from geographic information and services made available across any network, application, or platform.

OGC Mission

Our core mission is to deliver spatial interface specifications that are openly available for global use.

Open GIS Specifications

The Foundation for Collaboration

Homeland Security

E-Government

Insurance/Re-Insurance

Earth Systems Science

Defense & Intelligence

Real Property & Land Information

Sustainable Development

Mobile Enterprise

Web Mapping
Location-Based
Services
Sensor Webs

OGC
Web
Services

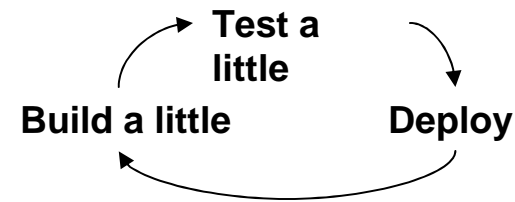
Modeling &
Simulation
Multi-Source
Operations
Decision Support



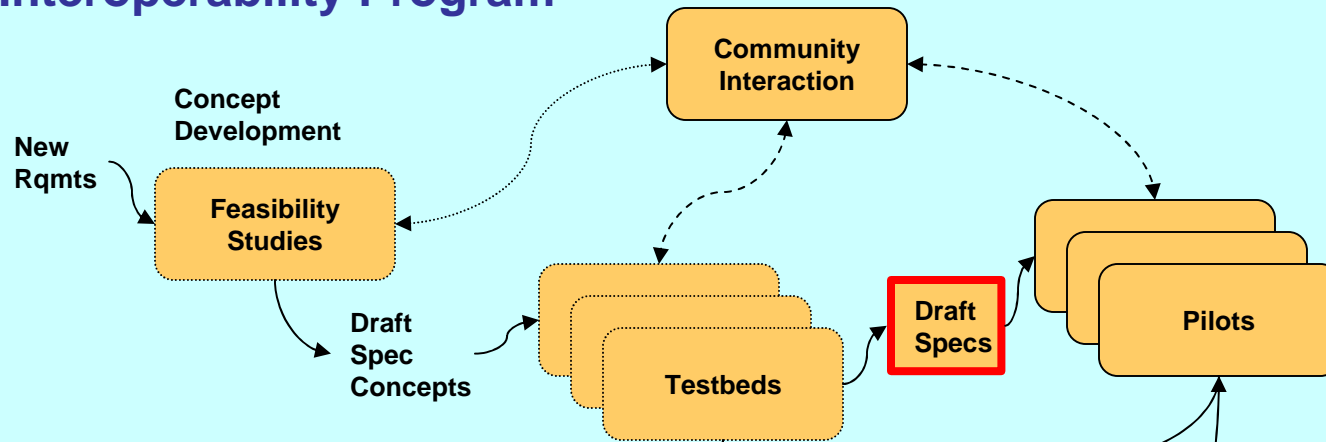
OGC members are facing the interoperability challenges of next-generation data sharing and collaboration....

Developing new specifications for geospatial interoperability and geo-enabling mainstream IT

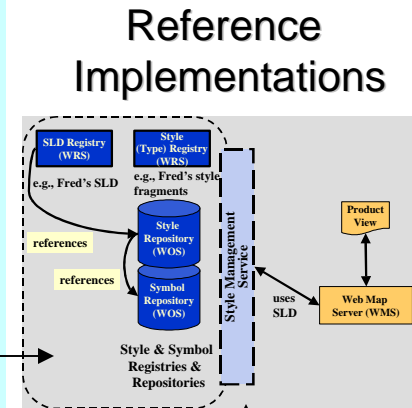
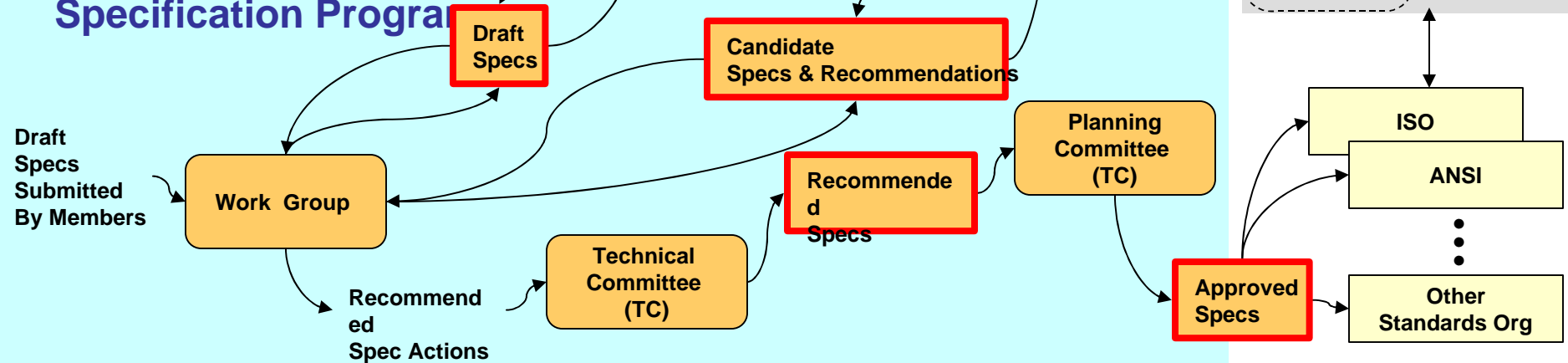
Advancing Specifications Through OGC



Interoperability Program



Specification Program





Sensor Web Enablement (SWE) Overview



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What is Sensor Web Enablement?

- The interoperability framework for accessing and utilizing sensors and sensor systems in a space-time context via Network protocols
 - The set of interfaces between users/applications and sensors/sensor systems
 - These interfaces can be easily adapted to other distributed computing platforms
- Conceived from the beginning to deal with all types of sensors and sensor systems
- Applications
 - Surveillance and reconnaissance for near real-time Joint Tactical Operations
 - Homeland security
 - Critical infrastructure protection
 - Emergency preparedness
 - Prevention, detection...
 - Emergency response and recovery
 - Disaster management
 - Emergency preparedness, response and recovery
 - Site monitoring and management
 - And many more....
- *Geospatial is a common, foundational property to exploit!*

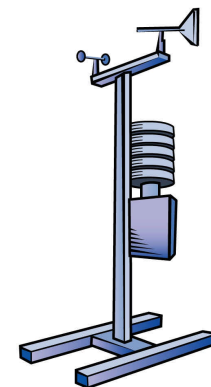
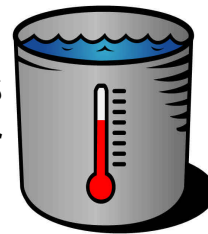
SWE Scope

- Built over the past two years through a series of fast-track collaborative engineering projects continued enhancement planned (with expanding participation)
- Define and develop a common framework for network-centric sensors and sensor systems
 - Common means to model and encode sensor and sensor platform data
 - Common means to model and encode sensor observations and measurements
 - Common set of interfaces to access and utilize sensor assets
- Supports heterogeneous sensor constellations
- Supports autonomous sensor operations

OGC Sensor Web

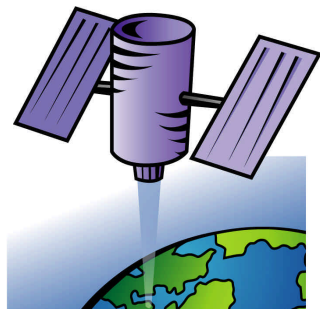
- All sensors connected to the Network
- All sensors report position & observations
- Sensor modeling and encoding: SensorML
- Observation modeling and encoding: O&M (GML-based)
- Access observations through *Sensor Collection Services*
- Plan collections through *Sensor Planning Services*
- Access sensor-related metadata through *Web Registry Services*
- User notification through *Web Notification Services*
- Alerts through *Web Alert Services*

Industrial
Process
Monitor



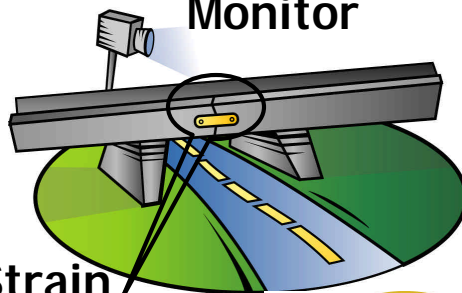
Environmental
Monitor

Airborne
Imaging
Device



Satellite-borne
Imaging Device

Traffic
Monitor

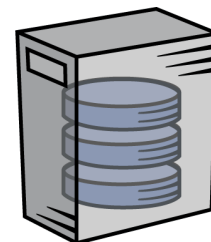


Strain
Gauge

Health
Monitor



Stored
Sensor
Data



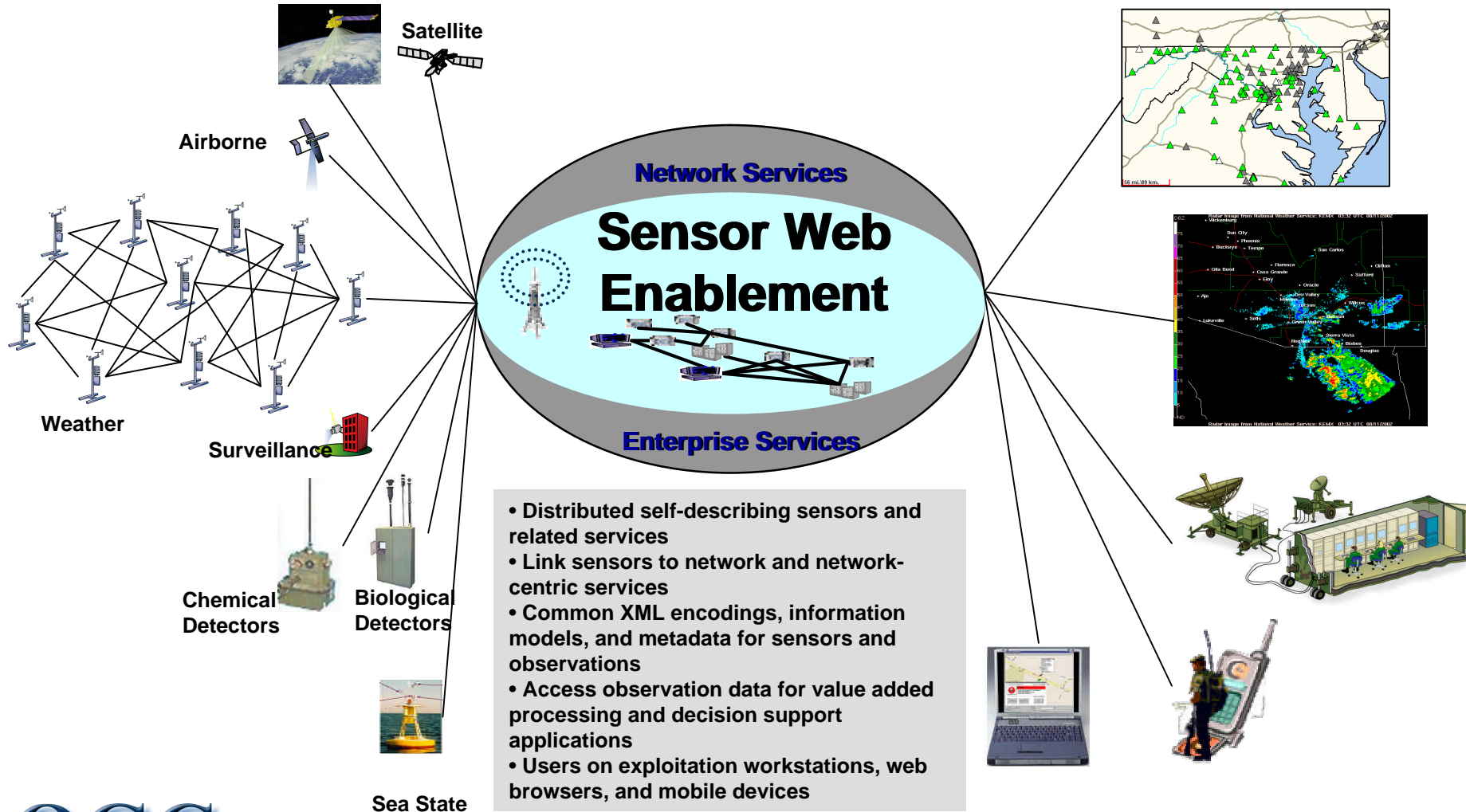
Webcam



SWE Operations Concept

Constellations of heterogeneous sensors

Vast set of users and applications

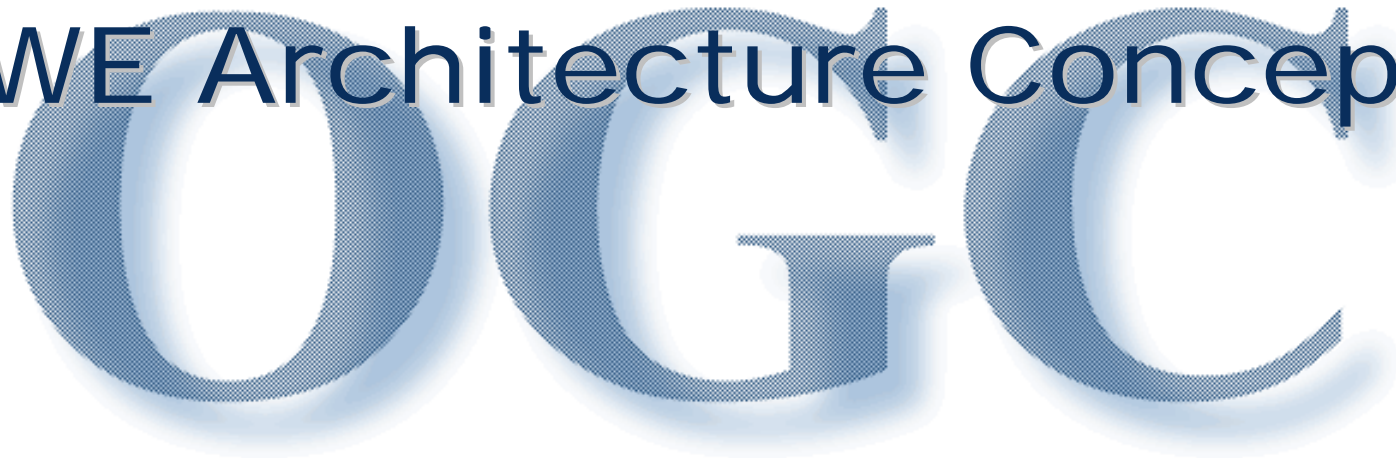


Current SWE Specifications

- **Sensor Model Language (SensorML)** – The information models and encodings for sensors and sensor platforms
- **Observations & Measurements (O&M)** – The information models and encodings for observations and measurements
- **Sensor Collection Service (SCS)** - Fetches Observations for a sensor or sensor constellation
 - The intermediary between a client application and an observation repository or near real time sensor channel
- **Sensor Planning Service (SPS)** – Determines collection feasibility and/or processes collection requests for a sensor or sensor constellation
 - The intermediary between a client and a sensor collection management environment
- **Web Notification Service (WNS)** – Executes and manages message dialogue between client and Web service(s) for long duration processes (asynchronous)



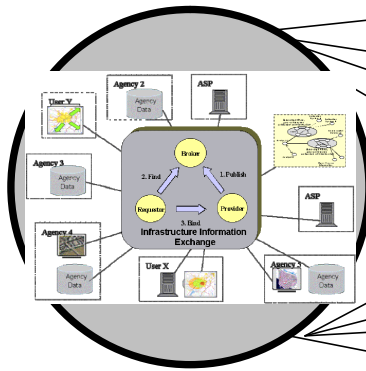
SWE Architecture Concepts



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A Common Reference Architecture

Sensor Web Enablement: An Information & Service Framework



**Based on OGC
Reference Model**

Enterprise viewpoint: articulates a business model that should be understandable by all stakeholders; focuses on purpose, operational objectives, policies, etc.

Information viewpoint: characterizes information content and system behavior (i.e., data models, schemas, semantics).

Computational viewpoint: captures component and interface details without regard to distribution.

Engineering viewpoint: exposes the distributed nature of the system and describes engineering constraints.

A Set of Specifications

Sensor Model Language (SensorML) for In-situ and Remote Sensors, OGC 03-005r1

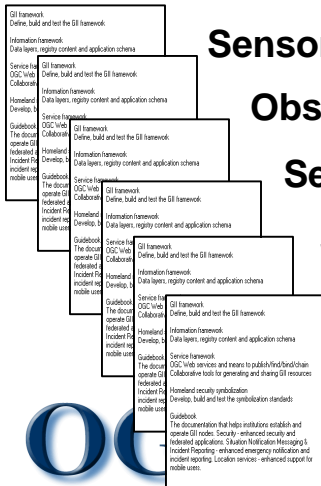
Observations & Measurements (O&M), OGC 03-022r3

Sensor Collection Service (SCS), OGC 03-023

Sensor Planning Service (SPS), OGC 03-011r1

Web Notification Service (WNS), OGC 03-008r1

Web Alert Service (WAS), Next testbed, OWS 2



A Common Information Model

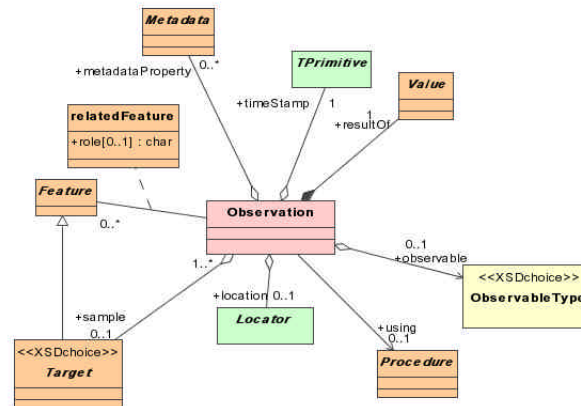
Sensor Models & Encodings (SensorML)

- Sensor identification
- Sensor constraints
- Observables and response characteristics
- Platform to which the sensor is attached
- etc

```
<ows:ObservedValue>
<ows:observable>
<ows:ParameterisedObservable gml:id="TMband1">
<ows:baseObservable xlink:href="#radiance"/>
<ows:parameter>
<ows:TypedValue>
<ows:axis xlink:href="#wavelength"/>
<ows:value>
<gml:ValueExtent>
<gml:low><gml:Quantity uom="#um">0.45</gml:Quantity></gml:low>
<gml:high><gml:Quantity uom="#um">0.52</gml:Quantity></gml:high>
</gml:ValueExtent>
</ows:value>
</ows:TypedValue>
</ows:parameter>
</ows:ParameterisedObservable>
</ows:observable>
<ows:value>
<gml:Quantity uom="#uV">52</gml:Quantity>
</ows:value>
</ows:ObservedValue>
```

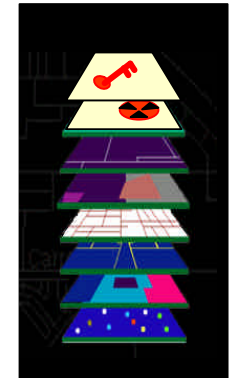
Observation Models & Encodings (O&M)

- Weather
- **Chemical, Biological,**
- Imagery
- .



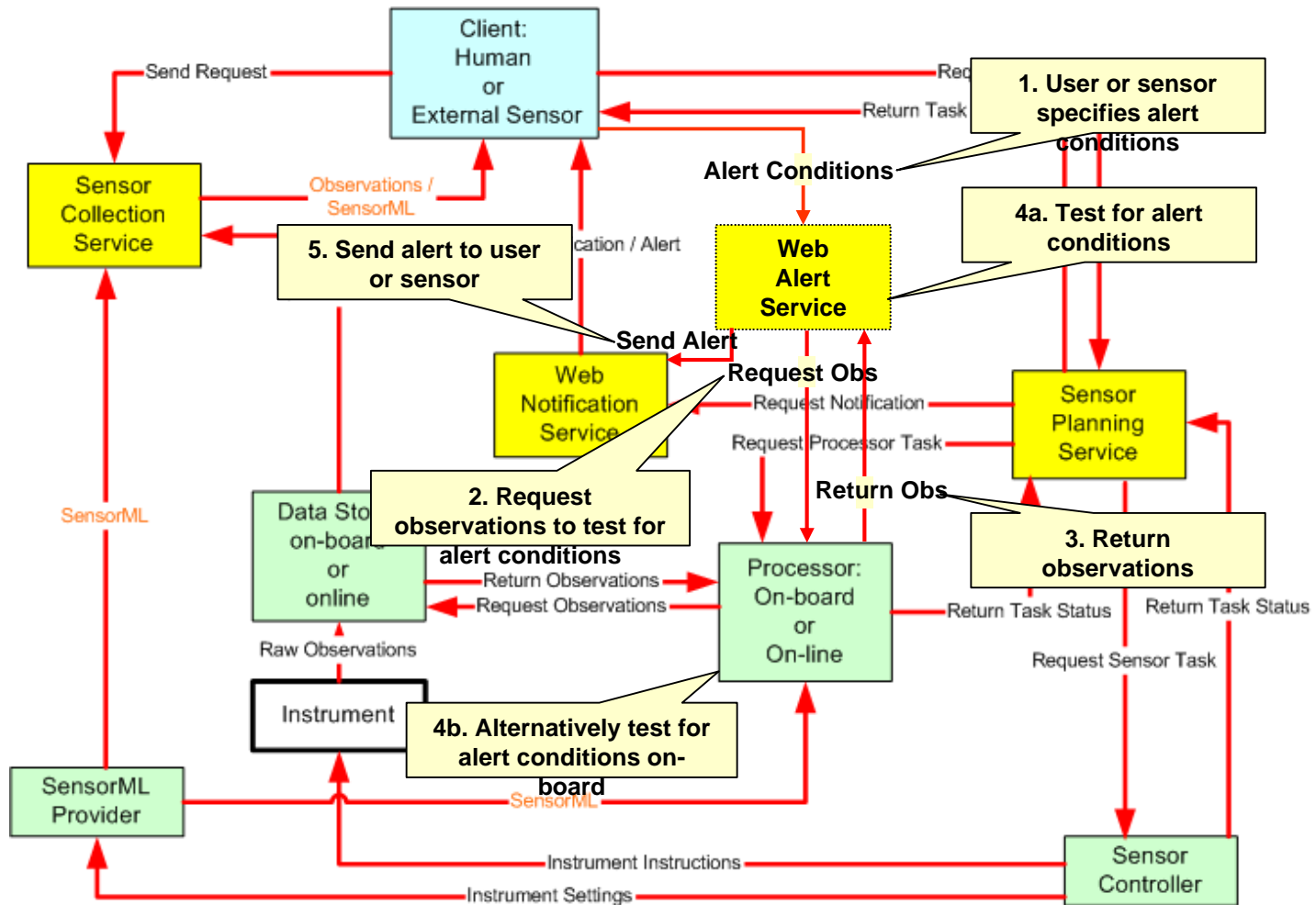
Layered Geospatial Info Model

- Boundary
- Population
- Critical infrastructure
- Terrain Elevation
- etc



Defines information types, properties, relationships, schemas, semantics and presentation styles and symbols

SWE Architecture

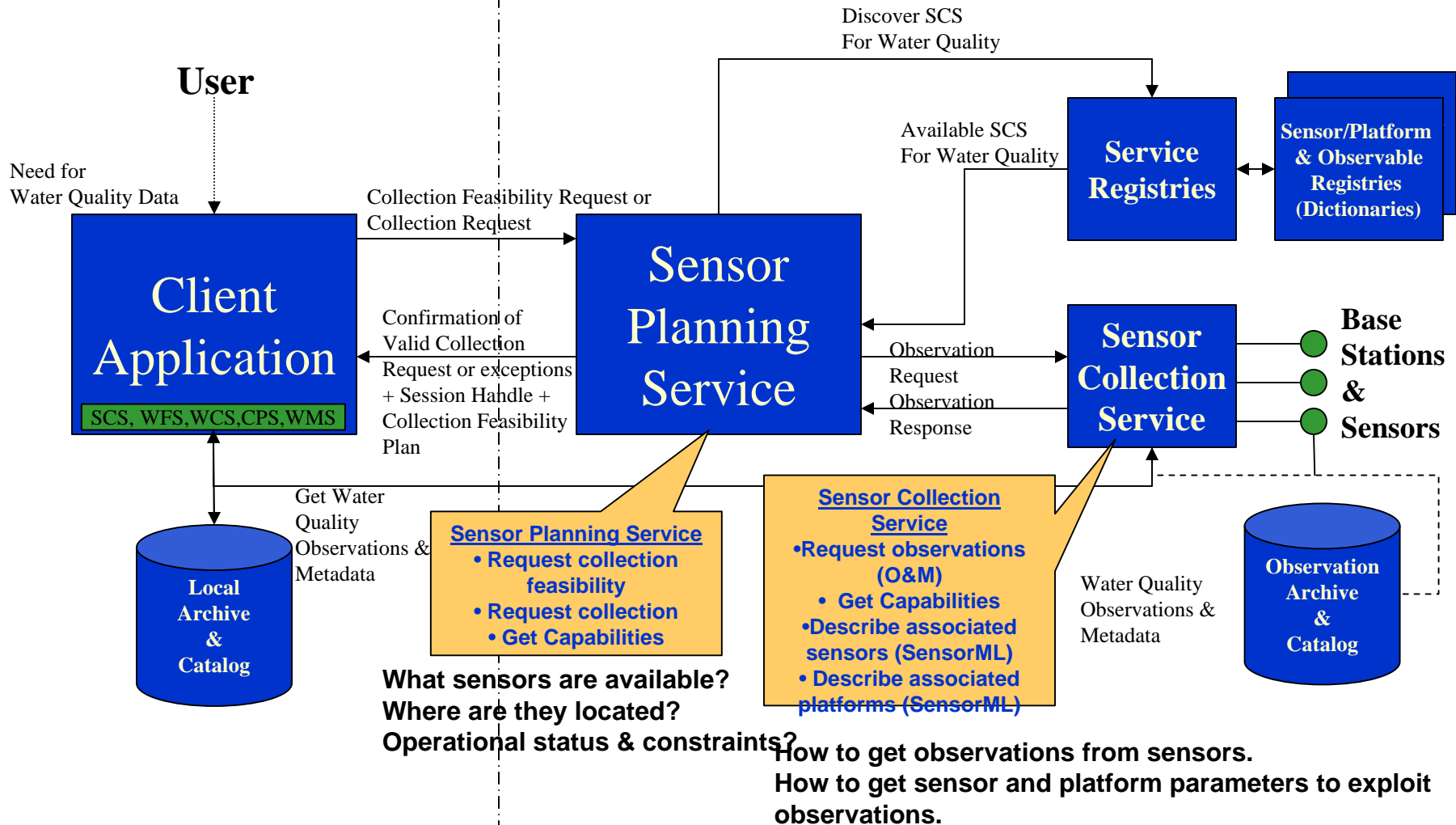


SWE services (yellow), SWE schemas (orange lettering), and other components of a sensing system (light blue)

Representative In Situ Sensor Configuration

User Environment

In Situ Collection Environment





OGC

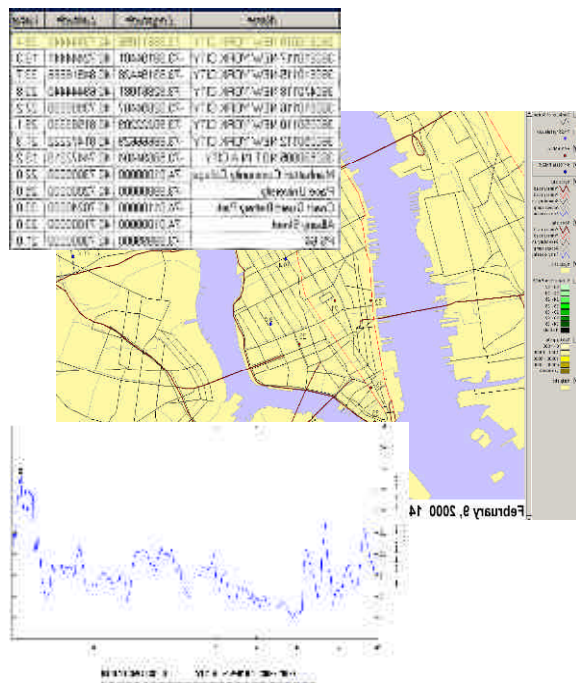
SWE Applications

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Feb 2002 Demonstration: Featured Toxic Dispersion Events & Environmental Sensors

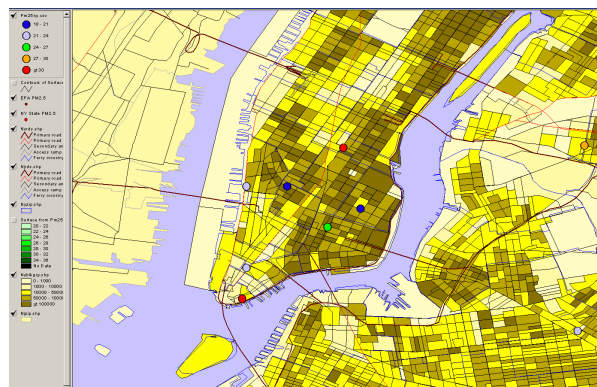
“Scientific” View

Analysts and emergency managers monitor conditions in near real time spatial-temporal context.



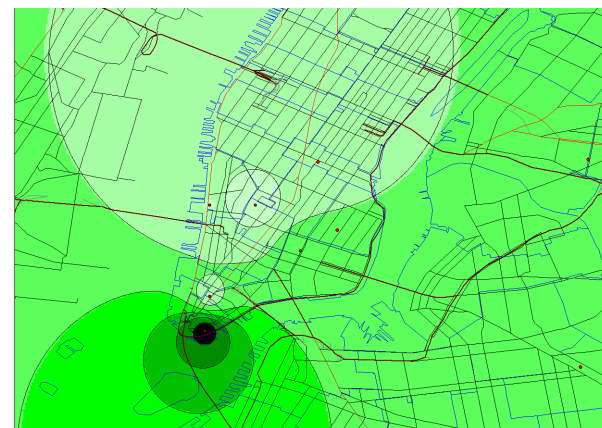
“Policy-maker” View

Hot spot areas are correlated with population data and other geospatial data. These maps are used to make decisions about evacuation routes and reoccupation zones.

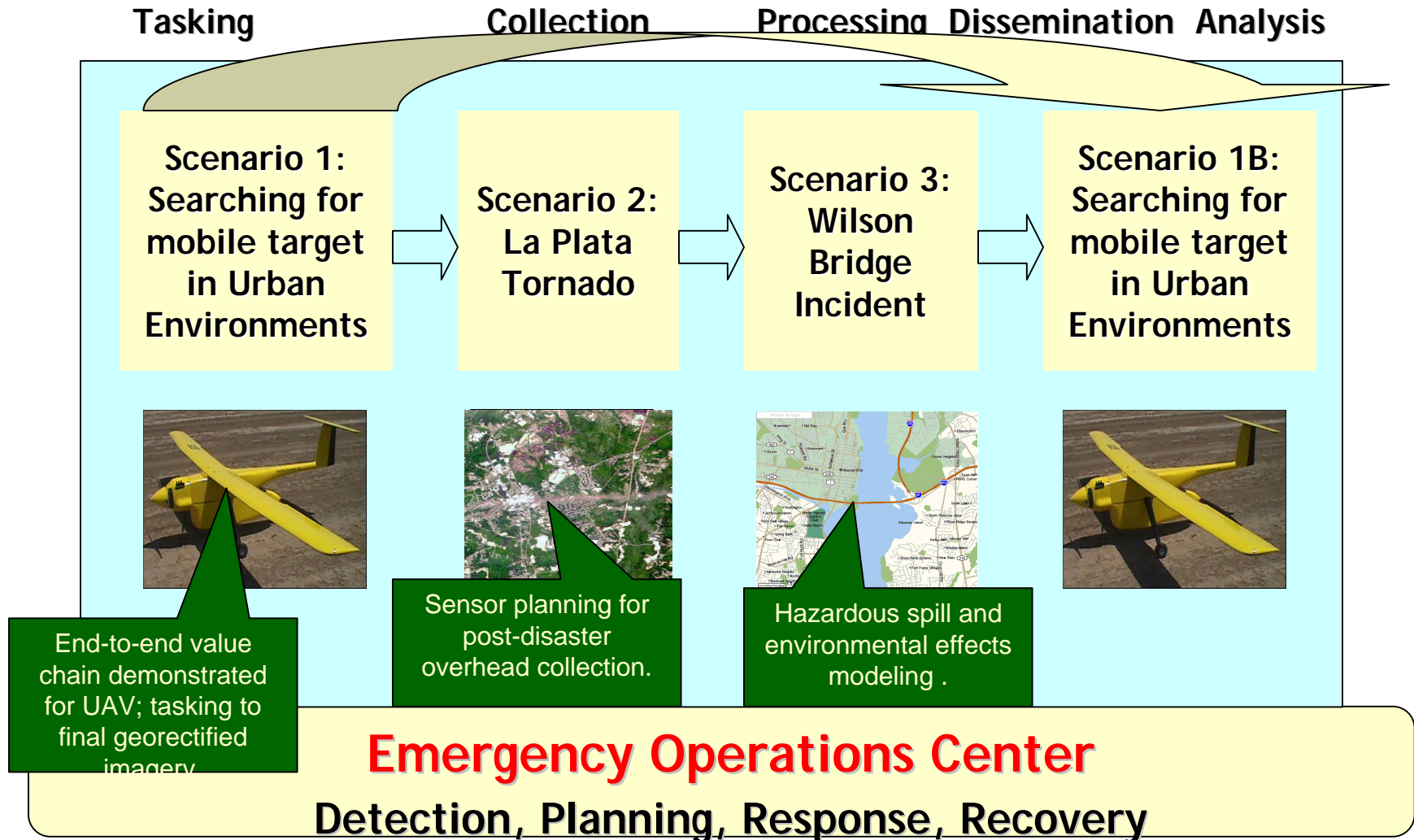


“Media/Public” View

Color coded symbols are used to indicate areas at risk and road closures. Other features and landmarks such as roads, buildings, and water bodies are used to add context.



Nov 2002 Demonstration: Featured UAV, Satellite and In-situ Sensors

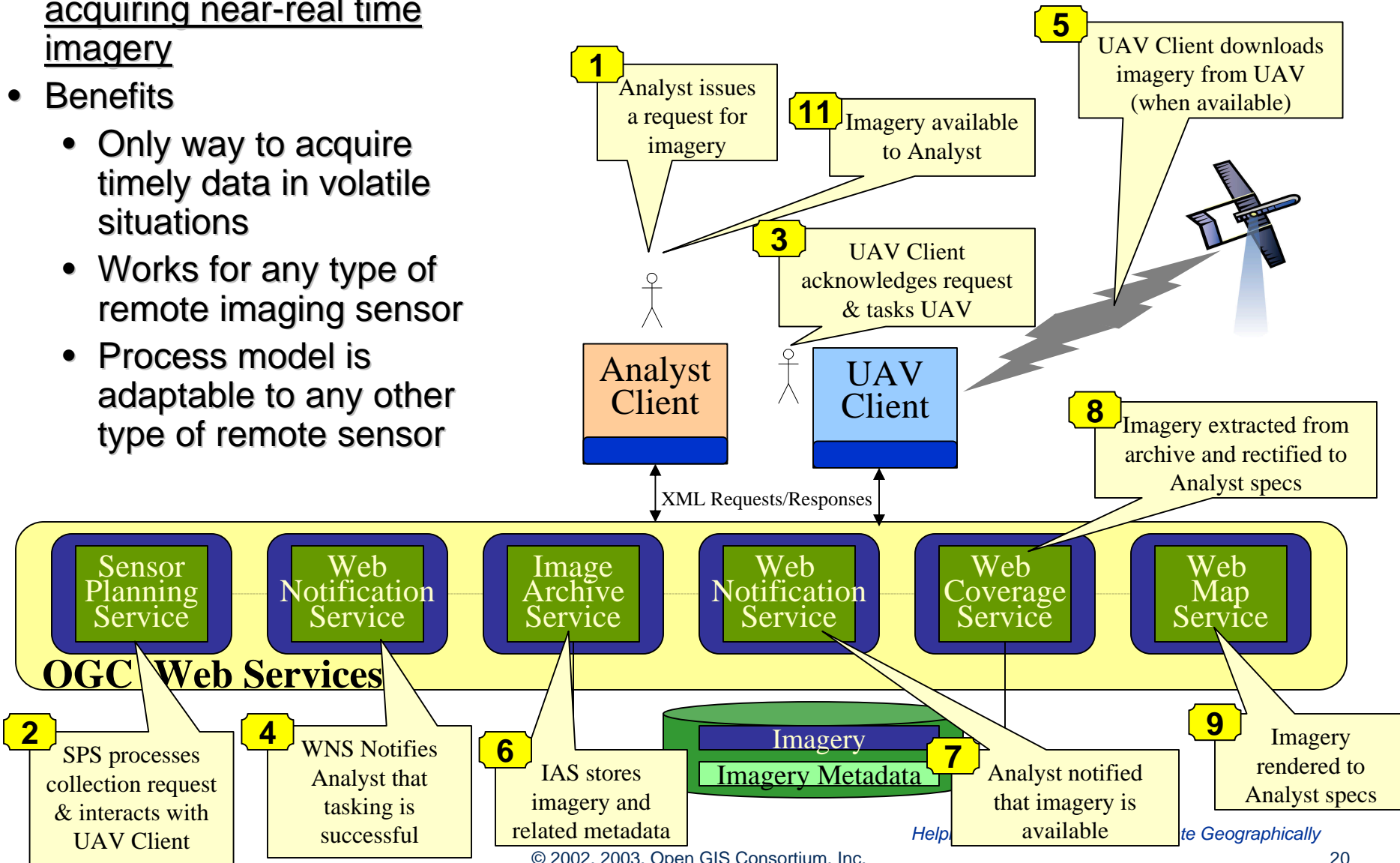


Imagery Tasking-Collection-Processing-Dissemination-Exploitation Chain

End-to-end solution for acquiring near-real time imagery

• Benefits

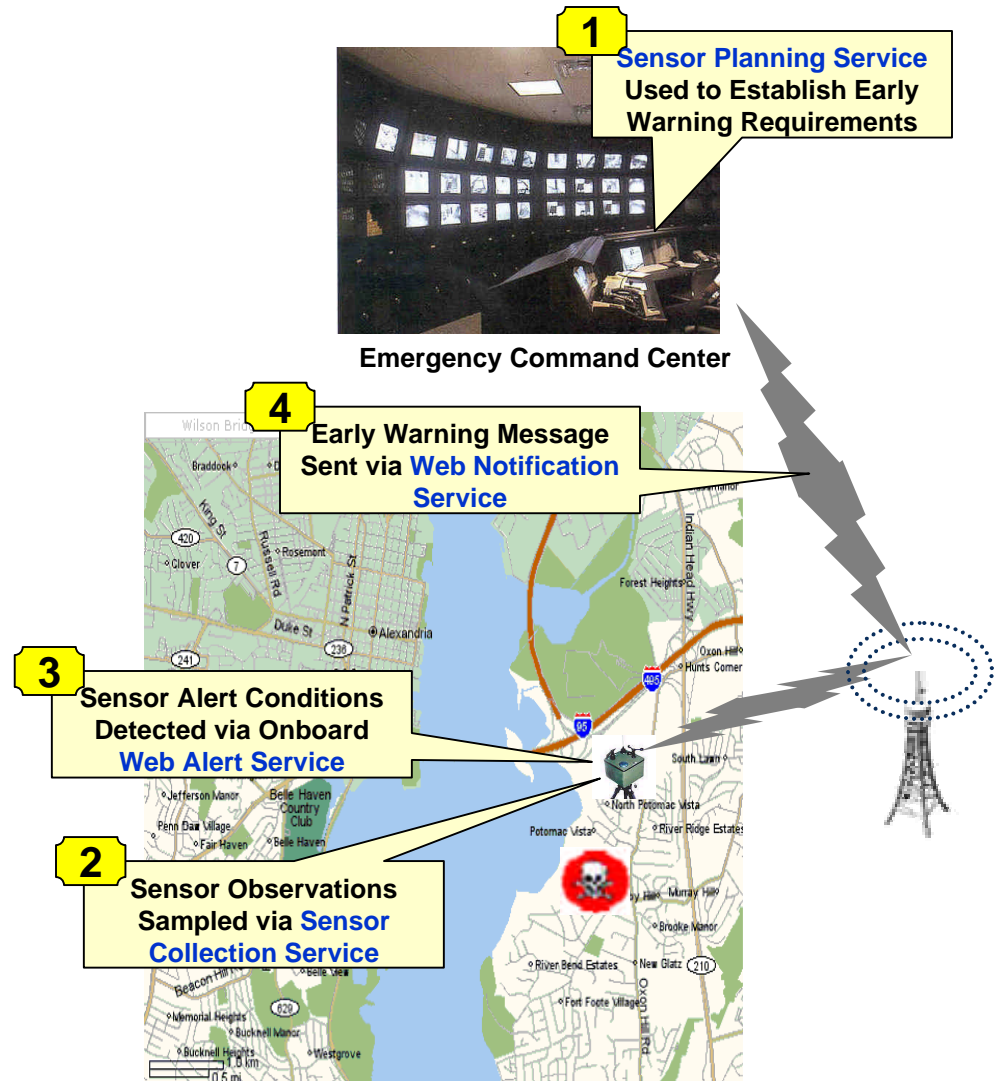
- Only way to acquire timely data in volatile situations
- Works for any type of remote imaging sensor
- Process model is adaptable to any other type of remote sensor



Chemical/Biological Threat Monitoring: Support Early Warning Notification

Early Warning Notification

- Common means for sharing location-based emergency notification messages
- Benefits
 - Can remotely control and monitor stationary and mobile detectors over broad area
 - Early detection and assessment is key to swift, effective response and mitigation
 - A network-centric sensor solution means that critical information is available to whomever needs it



Application to “Intelligent Jobsite”

- SWE Framework provides common, open services for tasking, monitoring, and collecting observations for any and all sensors
 - Also provides basis for expert group to formulate “application schemas” for construction metrology data exchange standards
- Makes sensors just another resource in jobsite applications: safety, security, materials management, asset management, maintenance management, equipment status, construction monitoring, performance monitoring, etc.
 - Would need to develop/enhance applications to exploit this framework
- A key to jobsite automation
- Especially important in time-critical applications that can’t be cost effectively accomplished with manual intensive methods
 - Use sensor resources for rapid detection and response
 - Man in the role of decision maker
- Essential for an accurate, shareable *common picture of the jobsite* (space-time context)
- Other OGC capabilities are germane to site modeling, analysis and visualization and facility life-cycle operations (e.g., now developing models for transportation industry)

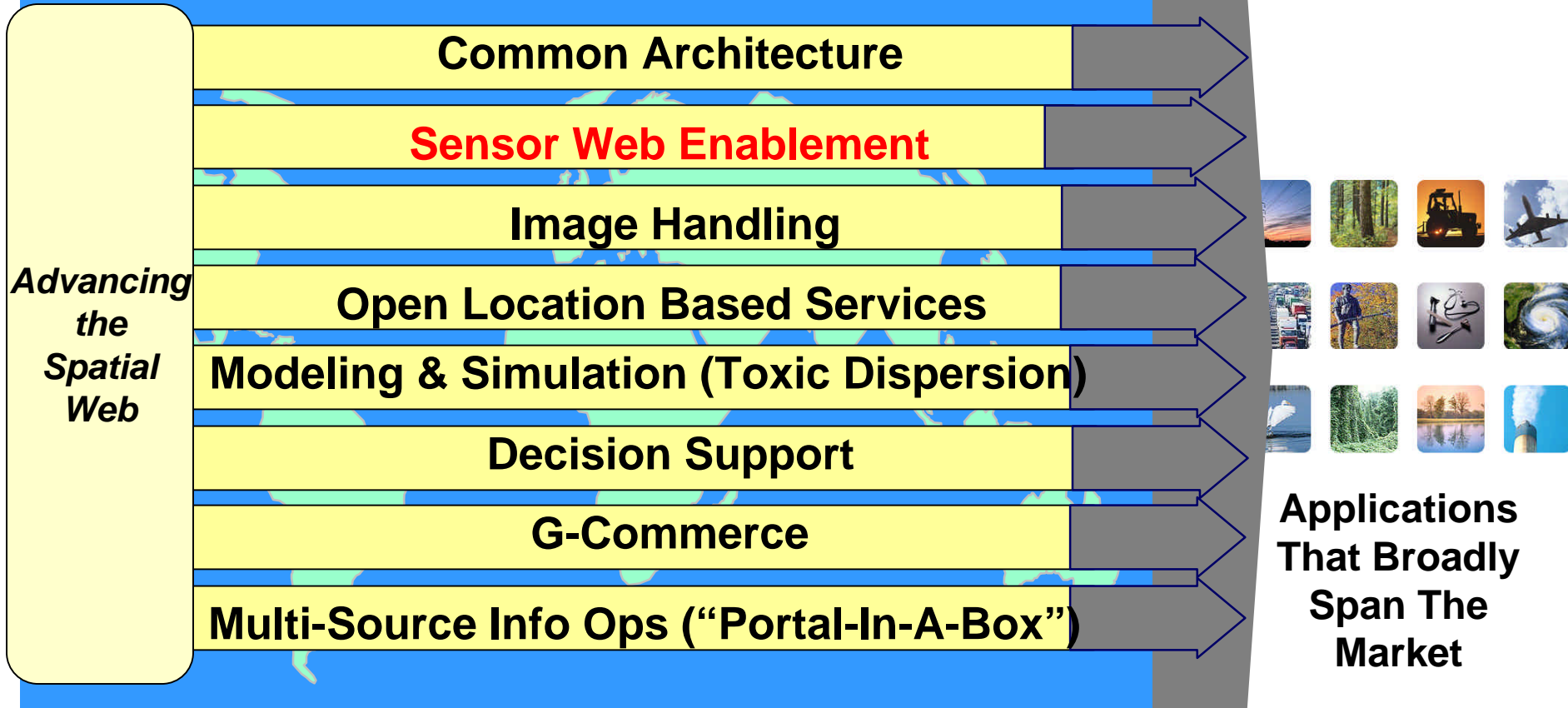


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SWE Development Plans

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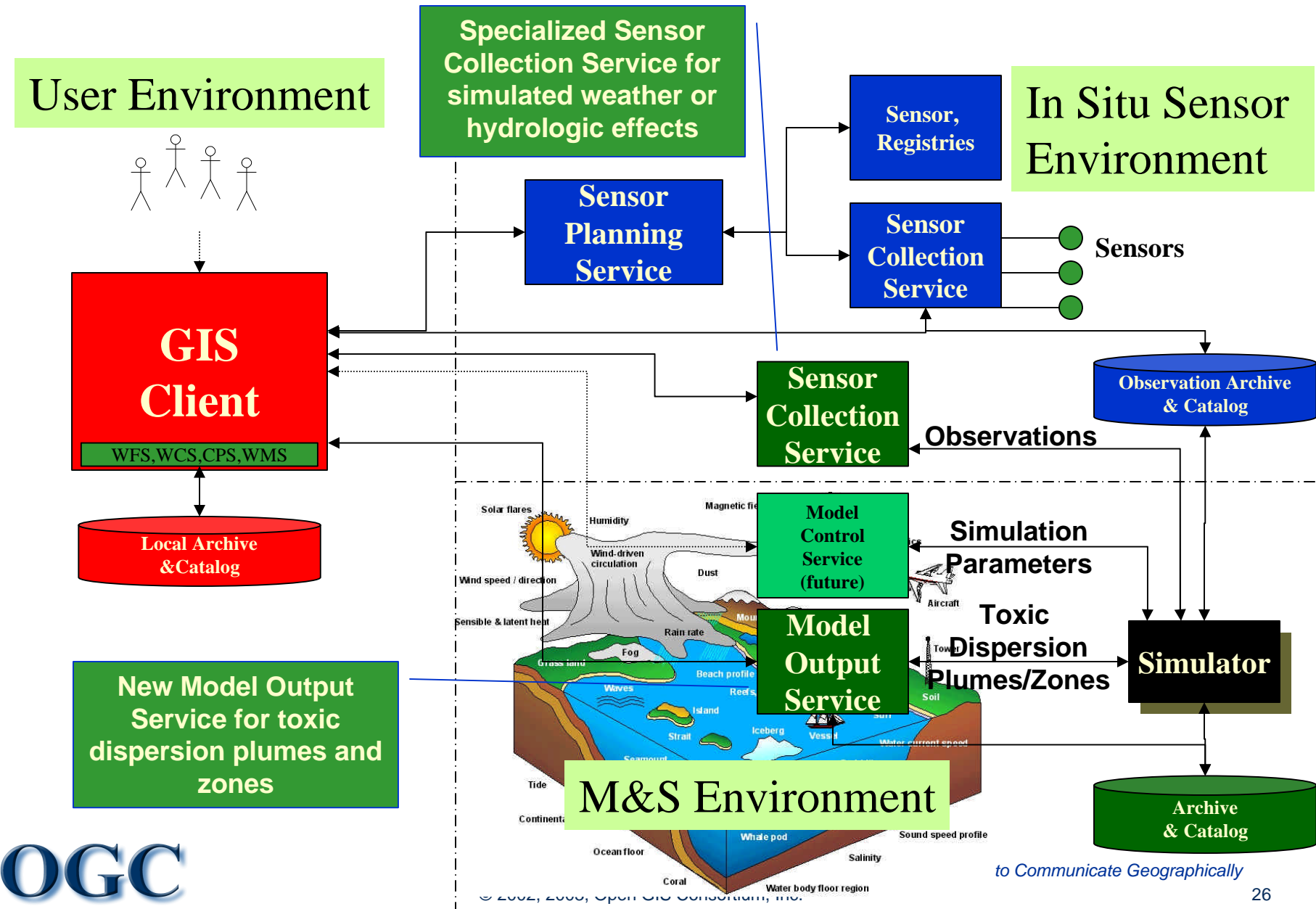
OGC Web Services Testbed, Phase 2: Starts Sept 2003



Current Understanding of SWE Objectives for OWS Phase 2

- Further refine and enhance capabilities defined under OWS Phase 1
 - New sensors and sensor systems
 - New observables
 - Enhance SensorML, O&M, SCS, SPS, and WNS based upon lessons learned
 - Registries for sensor types, observable types, sensors, and associated services for improved automation
- Alert and notification capabilities ... towards autonomous sensor operations
 - Enhance Web Notification Service
 - New Web Alert Service (WAS)
- Support “environmental simulation” (meteorological and hydrological) – toxic dispersion models

Also Combine SWE with Simulation for Environmental Effects



Schedule for OWS 2 Testbed Project

- Call for Sponsors
- RFQ released
- RFQ responses due
- Response Evaluation
 - *Sponsor meeting and final review*
- Initiative Kick-off
- Testbed Development
- Final demonstration

June '03

Early July

Early August

Late August

Mid September

Sept '03- Jul'04

Jul'04

How You Can Participate

- Get involved in the next phase of SWE development, the OGC Web Services, Phase II Testbed Initiative
 - Get involved as a sponsor to set development requirements and priorities
 - Get involved as a participant to define and prototype specifications
 - Contact Jeff Harrison, +1 (703) 491-9543, jharrison@opengis.org for more info
- Join OGC
 - Gain access to the specifications and stay connected to the active, growing SWE community
 - Work through the Specification Program to advance specifications
 - Go to the Website for a membership application, www.opengis.org
 - Contact Mark Reichardt, +1 (301) 840-1361, mreichardt@opengis.org for more info

Recommendations

- Sensor Web was designed for all types of sensors and applications, and thus is germane to the *Intelligent Jobsite*, so take advantage of the extensive work already accomplished
 - Good theoretical foundation
 - The core services have already been tested for many types of sensors
- Become actively involved in shaping the SWE Framework to more quickly realize your vision for an *Intelligent Jobsite* through involvement in the OWS 2 Initiative, as a sponsor and/or a participant
- Join OGC to get on the SWE bandwagon
- Form an expert group for construction metrology within the Sensor Web Work Group
- Folks like Mike Botts, PhD (author of SensorML and Chair of the Sensor Web Work Group) are a great asset!



Thanks!

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Open GIS Consortium, Inc.

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